INDOOR AIR QUALITY ASSESSMENT

Acushnet Elementary School
One Concord Road
Acushnet, Massachusetts

Prepared by:
Massachusetts Department of Public Health
Bureau of Environmental Health Assessment
July, 2002

Background/Introduction

At the request of the Acushnet Board of Health and parents, the Massachusetts Department of Public Health (MDPH), Bureau of Environmental Health Assessment (BEHA) provided assistance and consultation regarding indoor air quality concerns at the Acushnet Elementary School, One Concord Road, Acushnet, MA. On May 14, 2002, Cory Holmes, Environmental Analyst for BEHA's Emergency Response/Indoor Air Quality (ER/IAQ) Program, conducted an assessment of this building. Mr. Holmes returned with Michael Feeney, Director of BEHA's ER/IAQ Program on June 5, 2002 to conduct a follow up inspection of construction/renovation barriers and those areas directly impacted by ongoing construction. Concerns about poor indoor air quality related to construction/renovation prompted the request for an assessment. Findings and recommendations concerning renovations were outlined in two letters (MDPH, 2002a; MDPH, 2002b) sent previously. The letters are attached as Appendices I & II.

The school is under renovation while occupied by students, teachers and school administration employees. The building consists of four wings, each identified by color. During the assessment, students occupied the red, green and yellow wings. The yellow wing has been completely renovated; the red and green wings are scheduled for renovation during the summer of 2002. During the assessment, areas under construction/renovation included the former gymnasium and the blue wing classrooms (see Figure I).

During the BEHA assessments, the building was being continuously monitored by a private environmental consultant for total nuisance dust during renovations. Testing of various indoor air quality parameters (i.e. total nuisance dust, carbon dioxide, carbon monoxide, temperature, relative humidity, airborne pollen, mold, fibrous particulate, insect fragments,

airborne crystalline silica, volatile organic compounds, wipe and dust characterization of bulk samples) were also conducted by an environmental consultant Gurton, Elkerton and Associates (GE&A, 2002a; GE&A, 2002b; GE&A, 2002c; GE&A, 2002d; GE&A, 2002e).

Methods

Air tests for carbon dioxide, carbon monoxide, temperature and relative humidity were taken with the TSI, Q-Trak, IAQ Monitor Model 8551. Screening for total volatile organic compounds (TVOCs) was conducted using a Thermo Environmental Instruments Inc., Model 580 Series, Photo Ionization Detector (PID). The PID was calibrated using a span gas of isobutylene at 246 parts per million (ppm). Air tests for ultrafine particulates were taken with the TSI, P-Trak ™ Ultrafine Particle Counter Model 8525.

Results

The school houses kindergarten through fifth grades with a student population of approximately 715 and a staff of approximately 80. Tests were taken during normal operations at the school and results appear in Tables 1-2. No levels of carbon monoxide above background levels were measured in the building.

Discussion

Ventilation

It can be seen from the tables that carbon dioxide levels were elevated above 800 parts per million parts of air (ppm) in nine of fourteen areas surveyed, indicating inadequate air exchange in a number of areas. It should be noted that during the assessment the original air

handling units (AHUs) providing ventilation to the green and red wings were removed for replacement. In order to provide fresh air to occupied areas, temporary AHUs were installed. However, these units introduce a limited amount of air into the space and do not have the capacity to provide return/exhaust ventilation. In addition, the Acushnet Health Department ordered all windows closed to prevent potential infiltration of outside construction dust into occupied classrooms. Open windows can greatly reduce carbon dioxide levels.

The mechanical exhaust ventilation system in classrooms consists of grated, wall-mounted return vents that draw air back to rooftop AHUs. Exhausts were not functioning in the green and red wings during the assessment. Normally occurring environmental pollutants can build up and lead to indoor air complaints without removal by the exhaust ventilation system.

Elevated carbon dioxide levels (i.e. >800 ppm) were also measured in several areas in the new wing. As this system has recently been activated, BEHA staff recommended that school officials contact the school's HVAC contractor to adjust the AHU to increase outside air intake.

To maximize air exchange, the BEHA recommends that both supply and exhaust ventilation operate continuously during periods of occupancy. In order to have proper ventilation with a mechanical ventilation system, the systems must be balanced subsequent to installation to provide an adequate amount of fresh air to the interior of a room while removing stale air from the room. It is recommended that existing ventilation systems be re-balanced every five years to ensure adequate air systems function (SMACNA, 1994).

The Massachusetts Building Code requires a minimum ventilation rate of 15 cubic feet per minute (cfm) per occupant of fresh outside air or have openable windows in each room (SBBRS, 1997; BOCA, 1993). The ventilation must be on at all times that the room is

occupied. Providing adequate fresh air ventilation with open windows and maintaining the temperature in the comfort range during the cold weather season is impractical. Mechanical ventilation is usually required to provide adequate fresh air ventilation.

Carbon dioxide is not a problem in and of itself. It is used as an indicator of the adequacy of the fresh air ventilation. As carbon dioxide levels rise, it indicates that the ventilating system is malfunctioning or the design occupancy of the room is being exceeded. When this happens, a buildup of common indoor air pollutants can occur, leading to discomfort or health complaints. The Occupational Safety and Health Administration (OSHA) standard for carbon dioxide is 5,000 parts per million parts of air (ppm). Workers may be exposed to this level for 40 hours/week, based on a time-weighted average (OSHA, 1997).

The Department of Public Health uses a guideline of 800 ppm for publicly occupied buildings. A guideline of 600 ppm or less is preferred in schools due to the fact that the majority of occupants are young and considered to be a more sensitive population in the evaluation of environmental health status. Inadequate ventilation and/or elevated temperatures are major causes of complaints such as respiratory, eye, nose and throat irritation, lethargy and headaches. For more information concerning carbon dioxide, please consult Appendix III of this assessment.

Temperature measurements ranged from 70^{o} F to 75^{o} F, which were within the BEHA comfort guidelines. The BEHA recommends that indoor air temperatures be maintained in a range of 70^{o} F to 78^{o} F in order to provide for the comfort of building occupants. With the increase of outdoor temperature coupled with the lack of air conditioning and closing of windows, these conditions may lead to indoor temperatures above the recommended comfort

range. In many cases concerning indoor air quality, fluctuations of temperature in occupied spaces are typically experienced, even in a building with an adequate fresh air supply.

The relative humidity measured in the building ranged from 38 to 46 percent, which was within the BEHA recommended comfort range in most areas. The BEHA recommends a comfort range of 40 to 60 percent for indoor air relative humidity. Relative humidity levels in the building would be expected to drop during the winter months due to heating. The sensation of dryness and irritation is common in a low relative humidity environment. Low relative humidity is a very common problem during the heating season in the northeast part of the United States.

Microbial/Moisture Concerns

Water-damaged pipe insulation was observed in classroom 16 (see Picture 1). Fiberglass and paper wrapping around pipes are porous materials; if wetted repeatedly they can provide a medium for microbial growth.

Other Concerns

Testing was conducted for total volatile organic compounds (TVOCs) and ultrafine particulates (UFPs) during the assessment. No levels of TVOCs above background levels were measured in the building during the assessment. UFP counts were above background levels in a number of areas where there were slight breaches in the containment walls. BEHA staff recommended that these containments be rendered air tight with plastic polyethylene and duct tape (MDPH, 2002b) (see Appendix II).

Several conditions that can potentially affect indoor air quality were also identified. Exposed fiberglass insulation was noted around pipes in classrooms 14 and 16 (see Picture 2).

Also of note was the amount of materials stored in some areas. In many classrooms and common areas, items were seen piled on windowsills, tabletops, counters, bookcases and desks. The large amount of items stored provides a means for dusts, dirt and other potential respiratory irritants to accumulate. These stored items (e.g., papers, folders, boxes, etc.) also make it difficult for custodial staff to clean. Household dust and fiberglass particulates can become easily aerosolized and serve as a source of eye and respiratory irritation. In addition, fiberglass insulation material can also serve as a source of skin irritation to sensitive individuals.

Cleaning products were found on countertops and underneath sinks in a number of classrooms. Cleaning products contain chemicals, which can be irritating to the eyes, nose and throat. These materials should be stored properly and kept out of reach of students.

Classroom 14 contained a portable air purifier that is reportedly only run at night. These units are normally equipped with filters that should be cleaned/changed as per the manufacturer's instructions. In addition, the unit is designed to strain particulates from airflow and would be more beneficial to operate during classroom occupation.

The teachers' lounge contained photocopiers and a laminating machine. Laminating machines and photocopiers can give off irritating odors. Volatile organic compounds (VOCs) and ozone can be produced by photocopiers, particularly if the equipment is older and in frequent use. Ozone is a respiratory irritant (Schmidt Etkin, D., 1992). This area was not equipped with local exhaust ventilation to help remove excess heat and odors.

Conclusions/Recommendations

In view of the findings at the time of this assessment, the following recommendations are made:

1. Implement recommendations listed in previous BEHA correspondence (see Appendices I & II).
2. To maximize air exchange, the BEHA recommends that both supply and exhaust ventilation operate continuously during periods of school occupancy. Have an HVAC contractor determine if outside air intake can be increased in the new addition.
3. Ensure the mechanical ventilation system is properly balanced by an HVAC engineering firm once renovations are complete. Have the systems balanced every five years in accordance with Standard 111, SMACNA's HVAC Systems-Testing, Adjusting and Balancing, 2nd Edition.
4. For buildings in New England, periods of low relative humidity during the winter are often unavoidable. Therefore, scrupulous cleaning practices should be adopted to minimize common indoor air contaminants whose irritant effects can be enhanced when the relative humidity is low. To control for dusts, a high efficiency particulate arrestance (HEPA) filter equipped vacuum cleaner in conjunction with wet wiping of all surfaces is recommended. Drinking water during the day can help ease some symptoms associated with a dry environment (throat and sinus irritations).
5. Store chemicals and cleaning products properly and out of the reach of students. Ensure products are properly labeled in the event of an emergency for identification purposes.
6. Remove or encapsulate damaged/exposed fiberglass in classrooms.

7. Relocate or consider reducing the amount of materials stored in classrooms to allow for more thorough cleaning of classrooms. Clean items regularly with a wet cloth or sponge to prevent excessive dust build-up.
8. Clean filters for air purifiers as per the manufacturer's instructions or more frequently if needed. Operate during periods of classroom occupation.
9. Consider installing local exhaust ventilation in teacher's workroom during subsequent renovations.

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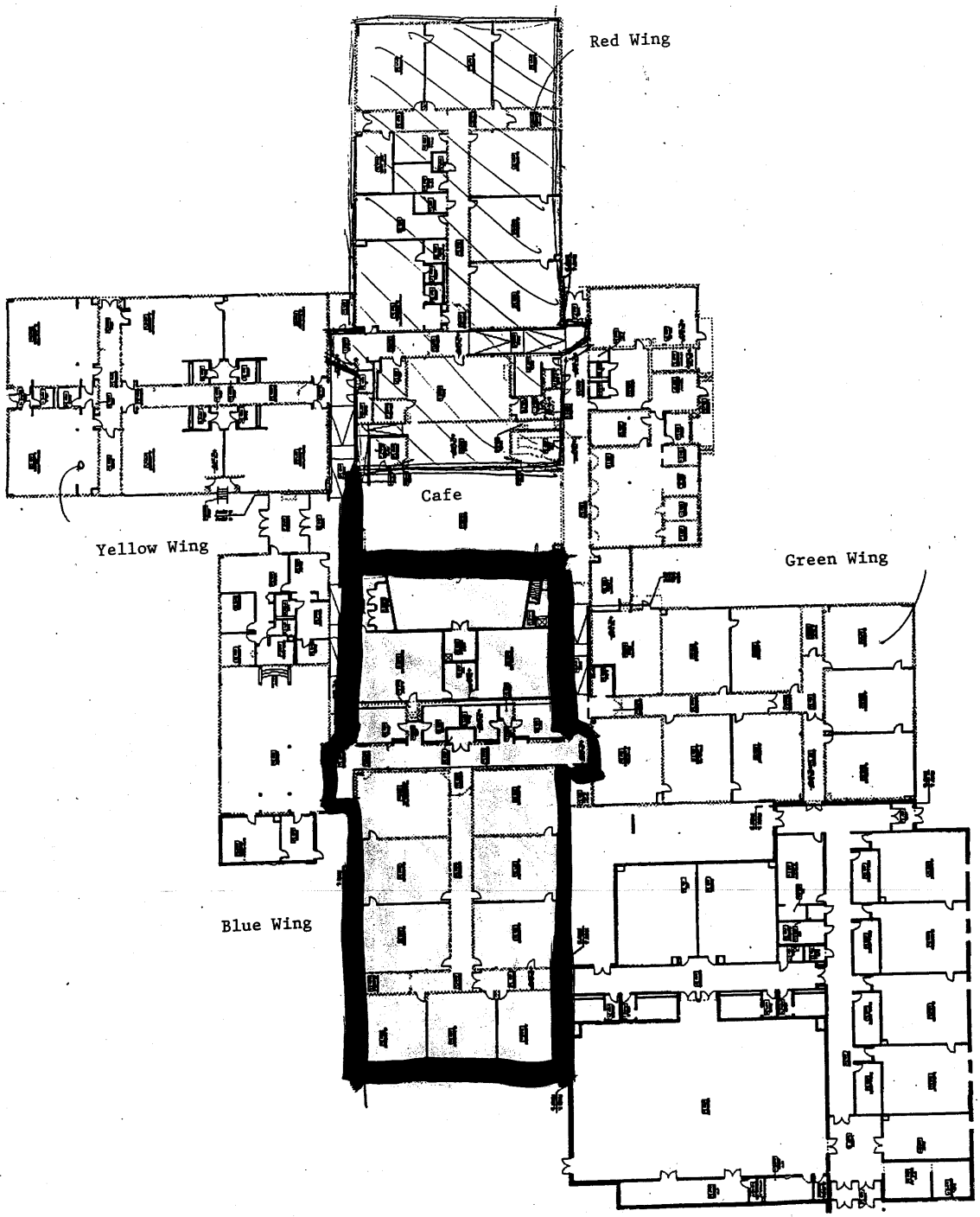
FIGURE I



Picture 1

Water-Damaged Pipe Insulation in Classroom 16

Picture 2

Damaged Pipe Insulation/Exposed Fiberglass

TABLE 1

Indoor Air Test Results – Acushnet Elementary School, Acushnet, MA – May 14, 2002

Location	Carbon Dioxide *ppm	Carbon Monoxide *ppm	Temp °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
							Intake	Exhaust	
Outside (Background)	441	0	62	45					weather conditions: cloudy-morning rain, breezy
Room 9	952	0	73	45	24	yes	yes	yes	window and door open, wall-mounted air conditioner, return not functioning
Room 10	800	0	73	44	20	yes	yes	yes	spaces around sink, return not functioning
Room 13	796	0	74	41	1	yes	yes	yes	door open, spaces around sink, spray cleaning product under sink
Room 16	725	0	75	39	20	yes	yes	yes	disinfectant on table, return vent obstructed, exposed fiberglass, water-damaged pipe insulation
Room 14	701	0	75	38	23	1	yes	yes	door open, occupants gone ~15 min., air purifier-only run at night, exposed fiberglass around pipes, cleaning product on countertop
Music Room	903	0	72	40	25	no	yes	yes	ceiling-mounted unit
Room 26	794	0	71	43	27	yes	yes	yes	door open, door seams sealed with duct tape, utility holes in

*** ppm = parts per million parts of air**
CT = ceiling tiles

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 2

Indoor Air Test Results – Acushnet Elementary School, Acushnet, MA – May 14, 2002

Location	Carbon Dioxide *ppm	Carbon Monoxide *ppm	Temp °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
							Intake	Exhaust	
									wall adjacent to construction, cleaning product on counter
Room 27	1076	0	72	46	28	yes	yes	yes	door open, spaces around sink, return vent sealed
Room 30	849	0	73	45	27	yes	yes	yes	
Teacher's Workroom	849	0	71	42	0	yes	no	no	no local exhaust, 2 photocopiers, laminator
Room 33	1094	0	71	45	23	yes	yes	yes	door open
Room 31	993	0	70	45	24	yes	yes	yes	door open
New Wing - Room 26	1063	0	71	44	25	yes	yes	yes	door open, return vent near open door, dry erase board
Akin	1050	0	71	44	24	yes	yes	yes	

*** ppm = parts per million parts of air**
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HOWARD K. KOH, MD, MPH
COMMISSIONER

May 30, 2002

Gerald Toussaint, Chairman
Acushnet Board of Health
130 Main Street
Acushnet, MA 02743

Dear Mr. Toussaint:

As you know, the Bureau of Environmental Health Assessment (BEHA) conducted an evaluation of indoor air quality at the Acushnet Elementary School on May 14, 2002. Cory Holmes, an Environmental Analyst in BEHA's Emergency Response/Indoor Air Quality (ER/IAQ) program, conducted the assessment. Concerns about pollutants generated by renovation efforts and their potential impact on occupied areas in this building prompted the request. A full report of BEHA's assessment is being prepared to address general indoor air quality in the building. This letter outlines renovation/construction issues and recommendations that BEHA believes should be implemented as soon as possible. It is important to note that the State Department of Education amended their regulations in 1999 to address such concerns for school renovation projects in Massachusetts (MDOE, 1999).

The school is currently under renovation while occupied by students, teachers and administrative staff. The building consists of a number of wings identified by color (see Figure 1). Students currently occupy the red, green and yellow wings. The yellow wing has been completely renovated; the red and green wings are scheduled for renovation during the summer of 2002. During the assessment areas currently under construction/renovation included the former gymnasium and the blue wing classrooms (see Figure I).

Prior to the BEHA assessment, the Board of Health, the Building Commissioner and the Fire Chief had visited the building a number of times, which led to a cease and desist order based on health and safety complaints. At the time of the BEHA assessment no construction/renovation activities were being conducted. Without activities generating pollutants, BEHA staff could not conduct air monitoring to examine the integrity of containment measures.

Town and school officials reported that the demolition in the gymnasium produced construction debris, airborne dusts and odors, which penetrated into the occupied areas of the school. Once demolition was stopped, several remediation steps were implemented including cleaning of the school's ventilation systems by a professional cleaning service and air monitoring for airborne particulates on a 24 hour a day basis (ABOH, 2002). Prior to completing a final report, BEHA staff will review these results. A temporary wall constructed of fire rated plastic polyethylene and duct tape was erected to separate the

gymnasium from the occupied cafeteria (see Picture 1). Plastic polyethylene sheeting was also erected on the interior of the gymnasium wall inside the construction zone, however prior to the BEHA assessment the plastic sheeting was removed, per order of the Fire Chief, to be replaced by fire-rated plastic polyethylene sheeting. Two local exhaust ventilation units equipped with high efficiency particulate arrestance (HEPA) filters were positioned within the construction area in a manner to draw airborne construction debris away from the cafeteria and outside the building (see Picture 2). Two large industrial sized exhaust fans were also placed in a construction door (see Picture 3) to help create depressurization and to minimize the potential of airborne contaminants to penetrate into occupied areas of the school. Gymnasium doors leading to the adjacent corridor were sealed with plastic polyethylene sheeting on the construction side and with duct tape on the occupied side (see Picture 4). Mr. Holmes recommended sealing these doors with plastic polyethylene sheeting and duct tape on the occupied side to create a secondary barrier.

In order to separate occupied areas from the construction zone, temporary walls of sheet rock were erected across corridors. Spaces in temporary walls and utility holes were sealed with duct tape, plastic sheeting, foam insulation or fiberglass materials (see Pictures 5 & 6) to prevent the migration of pollutants into occupied areas. Most of these barriers appeared intact, with the exception of a few areas where duct tape needed to be reattached/replaced (see Picture 7). BEHA staff also recommended that further examination and sealing of utility holes, pipes and wall cracks (see Pictures 8 & 9) be conducted in all containment barriers and existing classroom/hallway walls to eliminate any potential pathways of pollutant migration.

Renovation activities can produce a number of pollutants, including dirt, dust, particulates, and combustion products such as carbon monoxide (from construction vehicles). Particles generated from construction activities can settle on horizontal surfaces in classrooms. Dusts can be irritating to the eyes, nose and respiratory tract.

A number of pieces of construction equipment were operating around the perimeter of the building (see Picture 10). This type of activity should be closely monitored to avoid the entrainment of engine exhaust and other construction generated pollutants inside the building through open doors, windows or fresh air intakes. The nature of the construction has generated large amounts of dirt and debris outside of the building. The opening of windows allows for unfiltered air to enter the classroom environment, with the potential to carry with it dirt, dust and particulate matter. These materials can be irritating to the eyes, nose and respiratory tract. In order to prevent the entrainment of outside pollutants the Acushnet Board of Health has ordered the closing of all classroom windows.

The following recommendations should be implemented, for this project and any similar renovation/construction efforts, in order to reduce the migration of renovation generated pollutants into occupied areas:

1. Pursuant to 603 CMR 38.00: School Construction – Massachusetts Department of Education, "[a]pplicants shall implement containment procedures for dusts, gases, fumes, and other pollutants created during renovations/construction as part of any planned construction, addition to, or renovation of a school if the building is occupied by students, teachers or school department staff while such renovation and construction is occurring. Such containment procedures shall be consistent with the most current edition of the IAQ Guidelines for Occupied Buildings Under Construction published by the Sheet Metal and Air Conditioning Contractors National Association, Inc. (SMACNA). All bids received for school construction or renovations shall include the cost of planning and execution of containment of construction/renovation pollutants consistent with the SMACNA guidelines [608 CMR 38.03(13)] General Requirements: Capital Construction" (MDOE, 1999).

2. Establish communications between all parties involved with building renovations to prevent potential IAQ problems. Develop a forum for occupants to express concerns about renovations as well as a program to resolve IAQ issues.

3. Develop a notification system for building occupants immediately adjacent to construction activities to report construction/renovation related odors and/or dusts problems to the building administrator. Have these concerns relayed to the contractor in a manner to allow for a timely remediation of the problem.

4. When possible, schedule projects which produce large amounts of dusts, odors and emissions during unoccupied periods or periods of low occupancy.

5. Cover dirt/debris piles with tarps or wet down to decrease aerosolization of particulates.

6. Faculty should be aware of construction activities, which may be conducted in close proximity to their classrooms. In certain cases, classrooms adjacent to construction activities may need to have their HVAC equipment deactivated and windows closed periodically to prevent unfiltered air and vehicle exhaust from entering the building. For this reason, prior notification(s) should be made.

7. Disseminate scheduling itinerary to all affected parties, this can be done in the form of meetings, newsletters or weekly bulletins.

8. Obtain Material Safety Data Sheets (MSDS) for all construction materials used during renovations and keep them in an area that is accessible to all individuals during periods of building operations as required by the Massachusetts Right-To-Know Act (MGL, 1983).

9. Consult MSDS' for any material applied to the effected area during renovation(s) including any sealant, carpet adhesive, tile mastic, flooring and/or roofing materials. Provide proper ventilation and allow sufficient curing time as per the manufacturer's instructions concerning these materials.

10. Use local exhaust ventilation and isolation techniques to control for renovation pollutants. Precautions should be taken to avoid the *re-entrainment* of these materials into the building's HVAC system. The design of each system must be assessed to determine how it may be impacted by renovation activities. Specific HVAC protection requirements pertain to the return, central filtration and supply components of the ventilation system. This may entail shutting down systems (when possible) during periods of heavy construction and demolition, ensuring systems are isolated from contaminated environments, sealing ventilation openings with plastic and utilizing filters with a higher dust spot efficiency where needed (SMACNA, 1995).

11. Seal utility holes, spaces in roof decking and temporary walls to eliminate pollutant paths of migration. Inspect these areas regularly (e.g., daily) to ensure integrity is maintained.

12. If possible, relocate susceptible persons and those with pre-existing medical conditions (e.g., hypersensitivity, asthma) away from areas of renovations.

13. Implement prudent housekeeping and work site practices to minimize exposure to renovation pollutants. Consider increasing manpower or work hours to accommodate increase in dirt, dust accumulation due to construction/renovation activities. This may include constructing barriers, sealing off areas, and temporarily relocating furniture and supplies. To control for dusts, a high efficiency particulate air filter (HEPA) equipped vacuum cleaner in conjunction with wet wiping of all surfaces is recommended.

14. Close windows adjacent to construction activities to prevent unfiltered air from entering the building.

15. Consider changing HVAC filters more regularly in areas impacted by renovation activities. Examine the feasibility of acquiring more efficient filters for these units.

We suggest that these steps be taken on any renovation project within a public building. Please feel free to contact us at (617) 624-5757 if you are in need of further information or technical assistance.

Sincerely,

Suzanne K. Condon, Assistant Commissioner
Bureau of Environmental Health Assessment

cc/ Mike Feeney, Chief, Emergency Response/Indoor Air Quality, BEHA
Cory Holmes, Emergency Response/Indoor Air Quality, BEHA
Dr. Harold Devine, Superintendent, Acushnet Public Schools
Thomas Fantozzi, Health Agent, Acushnet Board of Health
Thomas Fortin, Clerk, Acushnet Board of Health
Sylvia Jordan, Principal, Acushnet Elementary School
Chief Paul Cote, Acushnet Fire Department
Leo Lyonnais, Building Commissioner
Jorge Figueiredo, Mount Vernon Group Architects
Senator Mark C. Montigny
Representative Robert M. Koczera

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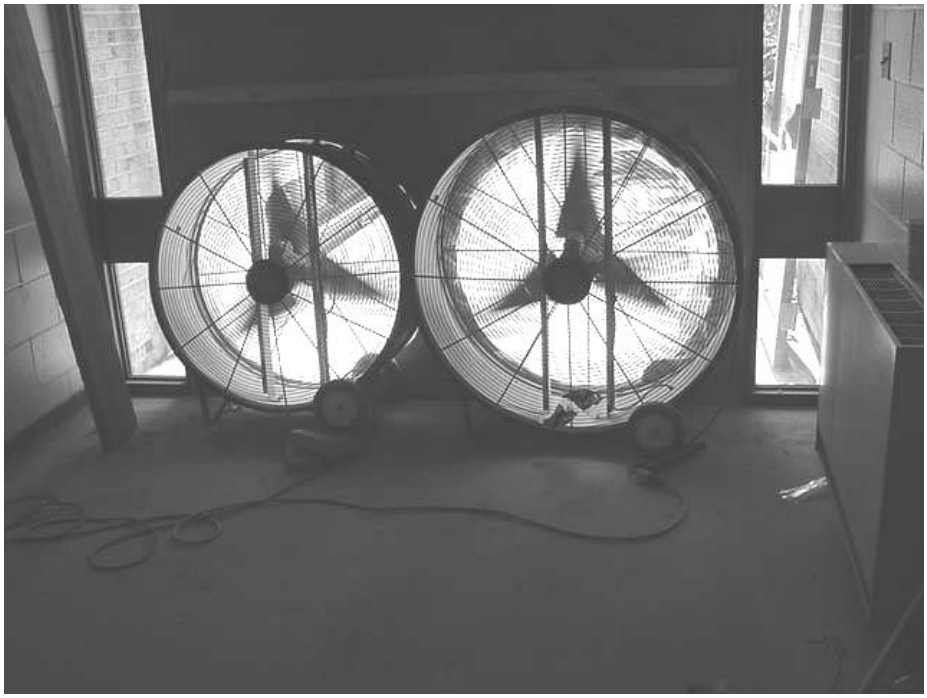
Picture 1

Plastic Poly Containment Wall in Cafeteria

Picture 2

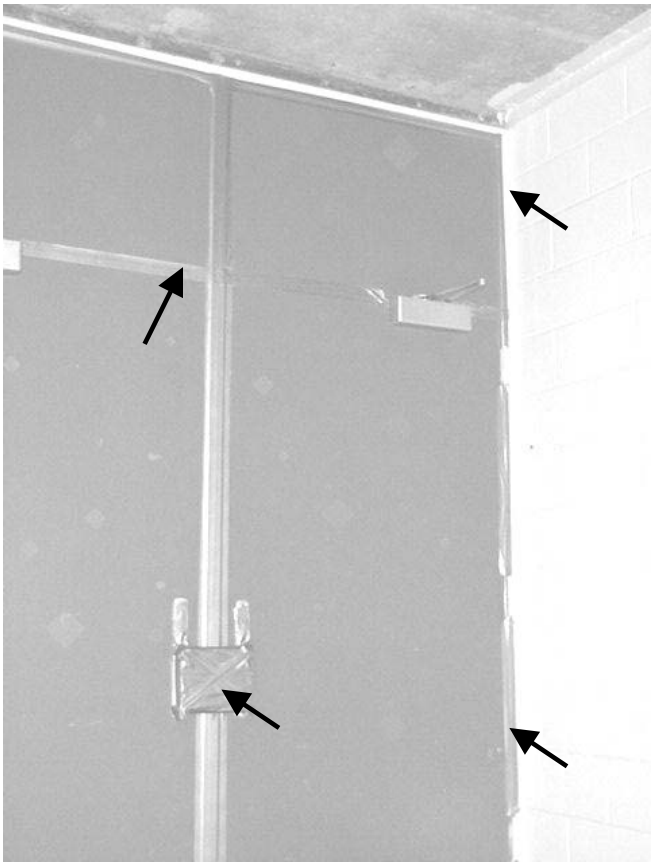
One of Two Negative Ventilation Units Equipped with HEPA Filters in Gymnasium

Picture 3



Exhaust Ventilation Fans in Construction Zone

Picture 4



Gymnasium Door Seams Sealed With Duct Tape

Picture 5

**Temporary Gypsum Wallboard Containment Barrier in Corridor,
Note Utility holes Sealed with Duct Tape**

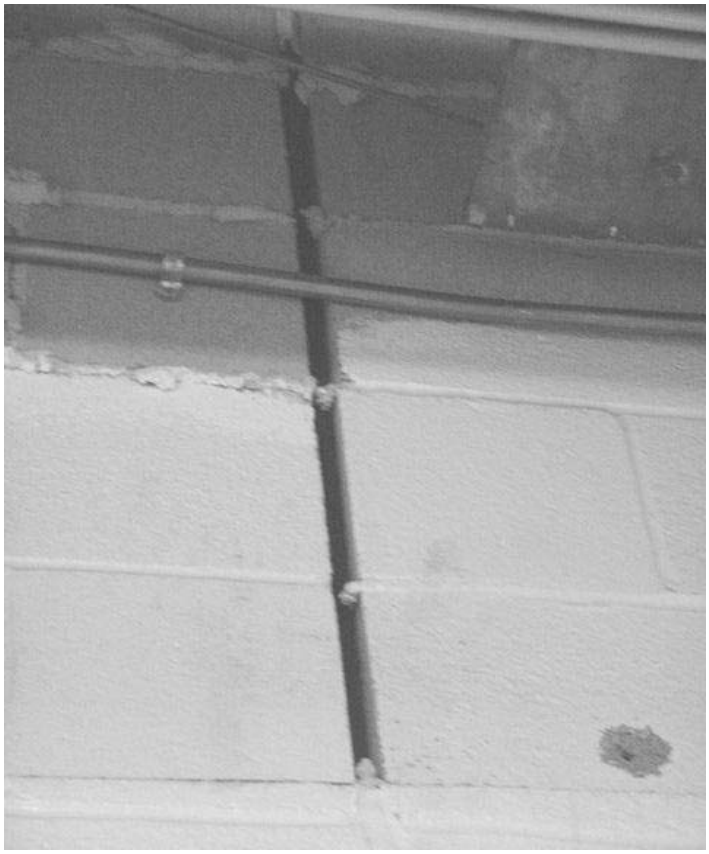
Picture 6

Picture Taken of Containment Barrier Shown in Previous from the Construction Side

Picture 7

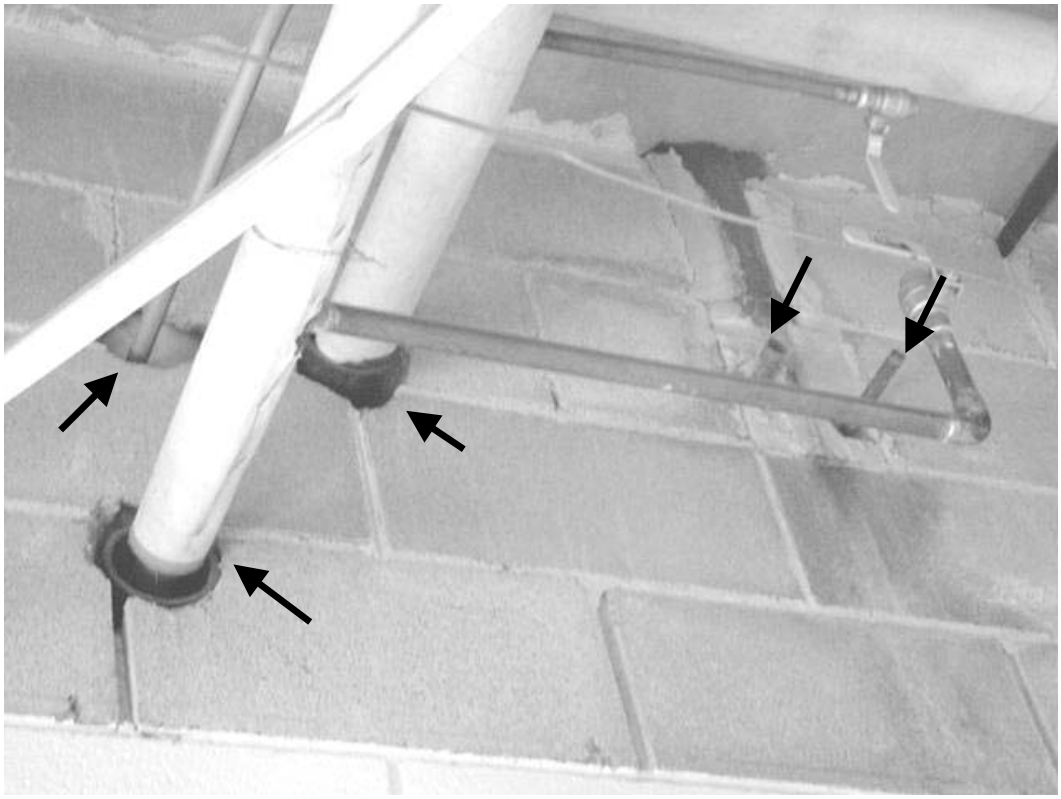
Close-up of Containment Barrier in Previous Picture, Note Loose Duct Tape and Plastic Poly Due to Dusty Conditions

Picture 8



Wall Crack in Corridor Adjacent to Construction

Picture 9



Open Pipes and Utility Holes in Classroom 26 Adjacent to Construction Zone

Picture 10

Construction Vehicle in Close Proximity to the Building

The Commonwealth of Massachusetts
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HOWARD K. KOH, MD, MPH
COMMISSIONER

June 14, 2002

Gerald Toussaint, Chairman
Acushnet Board of Health
130 Main Street
Acushnet, MA 02743

Dear Mr. Toussaint:

The Bureau of Environmental Health Assessment (BEHA) conducted an evaluation of indoor air quality at the Acushnet Elementary School on June 5, 2002. This evaluation was conducted as a follow-up to an initial visit by BEHA on May 14, 2002. Observation/ recommendations made during the May 14, 2002 visit were listed in previous BEHA correspondence (MDPH, 2002). School officials have reported that meetings have been held to discuss implementation strategies for the recommendations made in a BEHA letter dated May 30, 2002, which provided preliminary impressions.

Mike Feeney, Director of BEHA's Emergency Response/Indoor Air Quality (ER/IAQ) program, conducted the follow-up evaluation. Mr. Feeney was accompanied by Cory Holmes, an Environmental Analyst in BEHA's ER/IAQ program and Dr. Harold Devine, Superintendent of Acushnet Public Schools. Ongoing concerns about pollutants generated by renovation efforts and their potential impact on occupied areas in the building prompted the request. Parents reported to BEHA staff that materials used in roof installation had leaked into room 13 during school hours while occupied by students.

As discussed in our May 30, 2002 correspondence, the school is currently under renovation while occupied by students, teachers and administrative staff. The building consists of a number of wings identified by color. Students currently occupy the red, green and yellow wings. Renovations of the yellow wing are complete. The red and green wings are scheduled for renovation during the summer of 2002. During the assessment, areas currently under construction/renovation included the former gymnasium and the blue wing.

Renovation activities can produce a number of pollutants, including dirt, dust, particulates, and combustion products such as carbon monoxide (from construction vehicles). Particles generated from construction activities can settle on horizontal surfaces in classrooms. Dusts can be irritating to the

eyes, nose and respiratory tract. In order to minimize construction dust, the Acushnet School Department reported hiring two additional part-time maintenance personnel to assist in cleaning. School officials also reported that copies of construction related documents, including environmental testing results, are made available for review by all interested parties at three locations: the Acushnet Elementary School, the Acushnet School Department central office and on-site at the construction trailer. Parents and members of the public were reportedly made aware of the availability of these documents.

Construction activities (e.g. grinding, cutting, demolition) as well as the combustion of fossil fuels can produce particulate matter that is of a small diameter and can penetrate into the lungs and cause irritation. Idling vehicles can also provide opportunities for exposure to products of incomplete combustion such as carbon monoxide and soot. In addition, many products used during renovations (e.g. paints, finishes, mastics) contain volatile organic compounds that can produce eye and respiratory irritation. Air monitoring for several renovation-related pollutants (carbon monoxide, volatile organic compounds and ultrafine particles) were conducted by BEHA staff. Tests were taken under normal operating conditions. Test results appear in the attached tables.

No levels of carbon monoxide or total volatile organic compounds (TVOCs) above background levels were measured in the building during the follow-up assessment. In order to separate occupied areas from the construction zone, temporary walls of sheet rock were erected across corridors. BEHA staff detected levels of ultrafine particle (UFP) counts above background levels beneath the door adjacent to the gymnasium (see Picture 1). The most likely source of UFPs was determined to be the operation of construction vehicles in close proximity to the building (see Picture 2). BEHA staff recommended that the exterior of this construction barrier be rendered air tight with plastic polyethylene and duct tape on both sides of the wall to prevent further migration of renovation generated pollutants into occupied areas of the building.

A temporary wall constructed of fire rated plastic polyethylene and duct tape was erected to separate the gymnasium from the occupied cafeteria. In addition, exhaust ventilation fans were in place within the renovation zone in a manner to draw airborne construction debris away from occupied areas. Depressurization of the renovation zone was apparent as evidenced by polyethylene barriers being pulled away from the occupied side of the barrier toward the construction zone (see Pictures 3 & 4).

BEHA staff also recommended that further examination and sealing of utility holes, pipes and wall cracks (see Pictures 5 - 7) be conducted in all containment barriers and existing classroom/hallway walls to eliminate any potential pathways of pollutant migration.

BEHA staff examined classroom 13 to investigate claims of roofing materials dripping through the ceiling into the occupied classroom. Room 13 is located in a section of the building that is away from the renovation zone. Prior to the BEHA visit, School department officials reported that inspectors from the U.S. Occupational Safety and Health Administration had visited the school to investigate the work site due to numerous parental telephone calls to that agency regarding the reported roof leak incident.

Dark spots of a material exist on the floor, easel, shelf and carpeting in an approximate 20 foot long by 6 foot wide section of the classroom roughly 15 feet from the hallway door. The source of these stains appears to exist within the classroom and not the roof for the following reasons.

1. BEHA staff conducted a visual inspection of the ceiling, and found no evidence whatsoever of leaking roofing material. The ceiling of classroom 13 was found to be wholly intact (no breaches) and free of stains (see Pictures 10 & 11). If a molten/liquid roofing material were to have entered the space via holes in the ceiling it would have left stains in insulation, support beams or other building ceiling structures directly above the stains found on the floor and desks. Removal of these stains would be extremely difficult, since ceiling insulation is porous and would be expected to absorb liquids to produce stains.
2. The pattern of staining on the floor is random, in a general pattern that is an approximate 45^{o} angle from walls. If roof leaks were from holes above roof supports, the spatter pattern would be expected to be in a general line pattern that would be perpendicular to walls, since the roof and other ceiling structures are installed perpendicular or parallel to classroom walls.
3. Classroom occupants reported similar stains on vertical surfaces (e.g. sides of bookcases and chalkboards) several feet above the ground (see Picture 12). Stains examined on vertical surfaces were roundish as opposed to elongated (teardrop shaped) and pointing towards the floor (see Figure 1). If the source of liquid that created the stains originated *above* the vertical surface, a typical teardrop pattern of staining should be produced. These stains are not teardrop shaped, but are of a stain pattern would indicate that the direction that the liquid was traveling was either on the same horizontal plane or below the vertical surface.

These observations, when considered with the following information provided by local officials to BEHA staff, also discount the source of the stains as roofing materials:

1. Local health and school officials who responded to the incident reported no presence of roofing material on the roof or associated odors of tar or solvent in that classroom.
2. School officials believed that a series of dark stains in this room were made by a marker or ink pen that had broken, splattering the contents on surfaces inside the classroom (see Pictures 8 & 9).
3. A broken marker/pen was reportedly found in a trashcan within room 13.
4. The roof of the new addition, not the area above classroom 13, was reportedly being worked on during the incident.
5. The roof material being installed is rubber membrane type, which is attached to the roof substrate by mastic, not a molten asphalt/tar roofing material as initially reported.

Based on visual observations by BEHA staff, reports from local health and school officials responding to the incident and an interview with the room 13 teacher, the most likely source of the splattered stains were from within the classroom, possibly by shaking of the ruptured pen found in the trash barrel by a student.

In view of conditions observed at the time of this follow-up indoor air quality assessment, the following recommendations are made in order to reduce the migration of renovation generated pollutants into occupied areas:

1. Continue to implement corrective actions/recommendations made in previous BEHA correspondence (MDPH, 2002).

2. Seal electrical outlets and any remaining utility holes in walls adjacent to construction/renovation activities, specifically in corridors and in classroom 26.

3. Erect secondary barrier of plastic polyethylene and duct tape at construction barrier adjacent to the gymnasium.

4. Designate a single responsible individual (as well as an alternate) to conduct daily inspections of construction barriers to ensure integrity is maintained.

5. Consider installing digital readout carbon monoxide detectors in areas directly outside of construction barriers.

6. Continue to work with environmental consultant to monitor potential airborne pollutants generated by renovation/construction activities.

We suggest that many of these steps be taken on any renovation project within a public building. Please feel free to contact us at (617) 624-5757 if you are in need of further information or technical assistance.

Sincerely,

Suzanne K. Condon, Assistant Commissioner
Bureau of Environmental Health Assessment

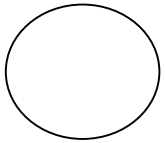
cc/ Mike Feeney, Director, Emergency Response/Indoor Air Quality, BEHA
Cory Holmes, Emergency Response/Indoor Air Quality, BEHA
Roy Petre, Environmental Policy Analyst, BEHA
Dr. Harold Devine, Superintendent, Acushnet Public Schools
Thomas Fantozzi, Health Agent, Acushnet Board of Health
Thomas Fortin, Clerk, Acushnet Board of Health
Sylvia Jordan, Principal, Acushnet Elementary School
Chief Paul Cote, Acushnet Fire Department
Leo Lyonnais, Building Commissioner
Jorge Figueiredo, Mount Vernon Group Architects
Senator Mark C. Montigny
Representative Robert M. Koczera

References

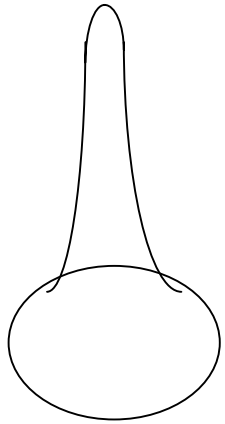
MDPH. 2002. Letter to Gerald Toussaint, Chairman, Acushnet Board of Health from Suzanne Condon, Assistant Commissioner, Bureau of Environmental Health Assessment concerning Renovations at the Acushnet Elementary School, Dated May 30, 2002. Massachusetts Department of Public Health, Bureau of Environmental Health Assessment, Boston, MA.

Figure 1

Individual Stain Pattern in Room 13



Typical Drip Pattern Seen from Source originating above a vertical surface



Picture 1

Doorway Adjacent to Gymnasium in New Addition

Picture 2

Construction Vehicle in Close Proximity to Building

Picture 3

Depressurized Gymnasium Construction Barrier, Note Plastic being Drawn Away From Occupied Hallway

Picture 4

Depressurized Gymnasium Construction Barrier, Note Plastic being Drawn Away From Occupied Hallway

Picture 5

Open Pipe in Hallway Adjacent to Construction

Picture 6

Electrical Outlet in Close Proximity to Construction Barrier in Foreground

Picture 7

Open Utility Holes in Classroom 26, Some Utility Holes were Sealed Others Were Not

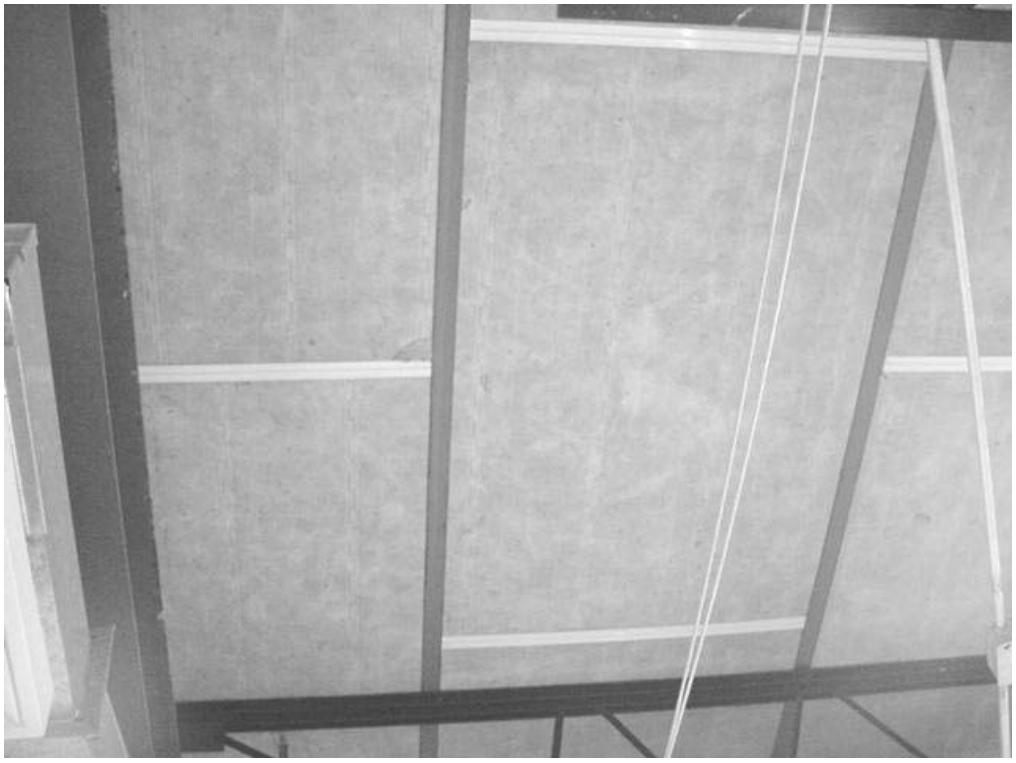
Picture 8

Splattered Stains on Floor of Classroom 13; Reported to be Roofing Material

Picture 9

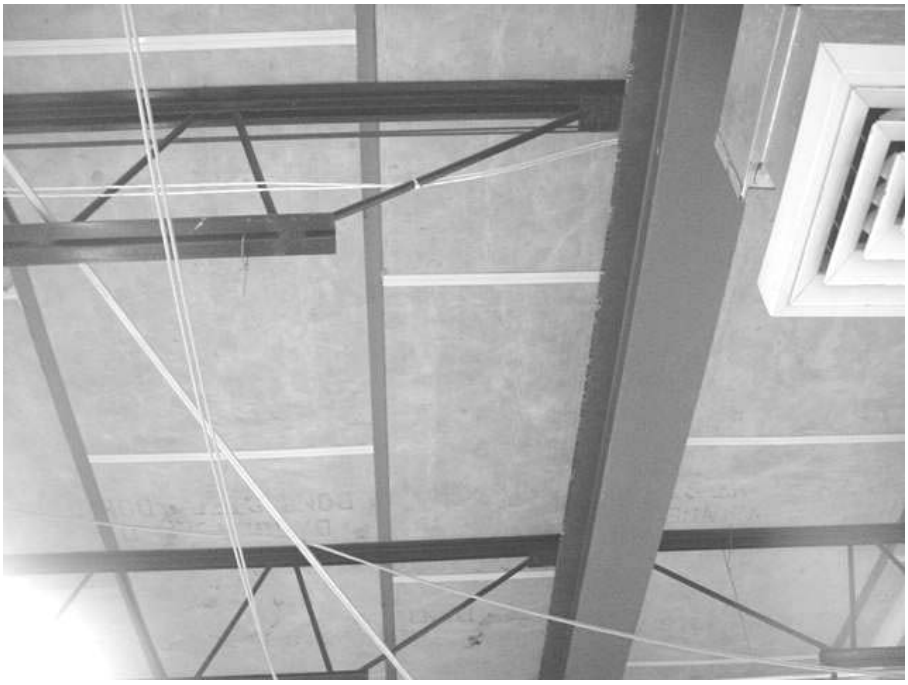
Area of Classroom Believed to be Where the Incident Occurred

Picture 10



Classroom 13 Ceiling above Splatters; Note Ceiling is Intact and Free of Staining

Picture 11



Classroom 13 Ceiling above Splatters; Note Ceiling is Intact and Free of Staining

Picture 12

Vertical Staining Pattern on Chalkboard in Classroom 13

TABLE 1

Indoor Air Test Results – Acushnet Elementary School, Acushnet, MA – June 5, 2002

Location	Carbon Monoxide *ppm	Total Volatile Organic Compounds *ppm	Ultrafine Particulates **1000p/cc^3	Remarks
Outside (Background)	1-3	0.5-0.7	8.4-18.9	school bus parking lot, construction vehicles
Library	0	0.5-0.7	9.8	
Library – at window	0	0.4	9.4	
Library – at containment wall	0	0.5	7.7 at open electrical conduit	
Library – at containment wall			7.5 at wall crack	
Library – at containment wall			6.3 at electrical outlet	
Library – at containment wall			8.8 at wall crack outside library	
Library – at containment wall			7.4 at center of hallway	
Containment Wall Outside Cafeteria	1	0.4		plaster bowed in – depressurized
Main Corridor Lobby	0	0.3	16.2 near vacuum cleaner	

*** ppm = parts per million parts of air**

Comfort Guidelines **CT = ceiling tiles**

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 2

Indoor Air Test Results – Acushnet Elementary School, Acushnet, MA – June 5, 2002

Location	Carbon Monoxide *ppm	Total Volatile Organic Compounds *ppm	Ultrafine Particulates **1000p/cc^3	Remarks
Cafeteria	1	0.5	10.0 at cafeteria center	around containment, no dirt/dust accumulation
Kitchen	1	0.5	22.5	cooking in progress, doors open to cafeteria & hallway
Cafeteria Hallway		0.3		utility holes
Room 13	0	0.3		reports of roof material dripping-drips/stains on floor-no evidence on ceiling directly above stains, splatters on vertical surfaces-no dripping, horizontal splatter patterns on bookshelf & easel, splatters beneath hanging lighting fixtures, no reports of water leakage
Cafeteria Hallway	2	0.4	9.1 at electrical panel conduit	
Cafeteria Hallway			11.8 at electrical outlet	wall crack near bean 1011
Hallway Outside Room 26			9.0	
Room 26	2	0.4	19.3	utility holes in wall-some utility holes filled/some not
Gym			18-19	light under door, ventilation off

*** ppm = parts per million parts of air**

Comfort Guidelines **CT = ceiling tiles**

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 3

Indoor Air Test Results – Acushnet Elementary School, Acushnet, MA – June 5, 2002

Location	Carbon Monoxide *ppm	Total Volatile Organic Compounds *ppm	Ultrafine Particulates **1000p/cc^3	Remarks
Hallway Outside Gym		0.4	19-20 at base of containment wall	light dust accumulation on door (recommend sealing plus poly)

*** ppm = parts per million parts of air**

CT = ceiling tiles

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%